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WASTE DISPOSAL AND LANDFILL: INFORMATION NEEDS

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ABSTRACT

The topic caters to information needs of waste disposal and landfill. The universal generation of waste has negative consequences on human activities. The study enables understanding of different types of waste and their consequences on human health and environment. . The main purpose of this study is to detail the risk of waste disposal for groundwater quality and entails the information required for assessment of risks. The initial section details about classification of waste and then after, explains storage, treatment and disposal of waste. It has also covered the factors governing contamination of groundwater by disposal of waste for understanding the major concerns of waste composition, leachate production and migration. The final section of study includes assessment of groundwater contamination related to waste sites. The increasing proportion of waste has to control in future and therefore, it is important to study significant aspects of waste disposal and landfill.

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1. WASTE DISPOSAL AND LANDFILL

The material which cannot be used further by owner and discarded is waste. It is considered that most of the discarded material can be recycles or reused. The philosophy of waste management also suggests that any material which is not of any use to one personal may of great use to other person. The practices of waste management are taking place in various countries and they are being conducted on a very organized and commercial basis. The generation of waste is universal and considered as direct consequences of activities of human beings. The waste can be liquid, solid or gaseous (Douglas, 2012). The gaseous waste is usually vented in the atmosphere. The treatment of gaseous waste depends on the regulations of country and the composition factors. Most of the liquid wastes are discharged in rivers or sewers within the countries. The discharge of liquid waste and its treatment depends

on legislations. It is clear that the indiscriminate liquid waste disposal leads to high level of pollution for groundwater as well as surface. Solid waste is mainly disposed to landfill because landfill is most cost cheapest and simplest method for disposal of this waste. Most of the countries are disposing solid waste into landfills (Spongberg, 2000). Moreover, the volume of waste produced is increasing in significant manner and landfill is considered as most effective source of groundwater contamination in future. The rate of waste generation, composition of solid waste, disposal treatment varies in different parts of world and determines the waste potential for impairment of groundwater quality.

2. TYPES OF SOLID WASTE

The wastes are generated from different activities of human beings and comprises of waste such as food, paper, metals, etc. These waste turns into toxic substances and harms the environment in considerable manner. There are different type of solid wastes such as municipal waste, household waste, health care waste, construction waste, industrial waste (hazardous and non-hazardous), animal waste and incinerator waste (Cotton, 2009). The major chunk of waste is collected by municipal which include office and shop waste, waste from restaurants, waste from street cleaning etc. The facility of waste storage can minimize the negative effects of waste within the environment. It can be achieved by restrictions of effluents from waste to particular location where emissions are controlled. There are various countries which have central waste disposal occurred by landfills. The control of emissions has to be adequate to avoid the sources of groundwater contamination. The legislation also has an important role to protect the usable groundwater and reduce the wrong practices in different countries. There are modern waste management practices such as sanitary landfills (Schneider & Johnson, 2012). There is a common practice for managing construction and demolition waste i.e. to bury the waste on the construction site from where the waste is generated. There is a risk of leaching heavy metals from construction waste by downward percolation of rainwater. Therefore, recent regulations in developed countries have considered that all type of construction and demolition waste need to be disposed in landfills. There is a categorization between hazardous and non-hazardous waste according to its capability to impact human ad environmental health. The characteristics of infections, chemical concentration, physical properties and quantity decide the impairment level of particular waste. In developed countries, industrial wasted, solid residues, fly ash are disposed in specialized landfills made for hazardous waste disposals (Tchobanoglous, 2013). Whereas, in under developed countries, there are common open dumps in which all types of wastes are dumped altogether which can be toxic and also delays the biodegradation process of substances such as leachate. Mostly, animal and human wastes are not disposed in landfills as they produce leachate in considerable quantities. There is a high concentration of pathogenic organism in human and animal waste which has potential to spread diseases. The generation and management of different types of waste vary in different areas of world.

3. STORAGE, TREATMENT AND DISPOSAL OF WASTE

The storage, treatment, disposal, collection and transport of waste have significant potential to increase the pollution in environment and especially groundwater because of uncontrolled fluids migration. These fluids are derived from unmanaged waste. There is a huge potential of groundwater pollution where waste is stored and produced before collection process. In addition, the groundwater pollution can also

occur where the sites are associated with disposal and treatment of wastes and leachate are generated including landfills and uncontrolled dumps. For the assessment of situation, landfills need to be identified with pollution level of groundwater by waste (Corry, 2008). However, the temporary waste site for concentration, processing and storage also has potential to contaminate groundwater. These processing facilities may not be completely licensed or regulated within the urban and semi-urban settings. The assessment of these locations will help in assessing the capability of pollution and potential groundwater pollution from waste disposal (County, 2009). Most of the landfills require operating licenses and need to be engineered efficiently for prevention of groundwater pollution. It involves site lining with artificial systems though these liners degrade with the time. Even if these sites are well managed and engineered, it is necessary to install artificial lining system. Therefore, it is necessary to evaluate the capacity of pollution to protect the groundwater pollution in case of failure of liner (Riediker, 2011). There is a likelihood of groundwater pollution by waste but it depends on the thick unsaturated zones and capacity of overburdened solid waste underlying the site. The total quantity of generated leachate is another function of access to waste. It indicates that there is a less potential of groundwater pollution where the advantage of positive geological conditions are taken. It is essential to locate the waste disposal sites including historic dumps, operating landfills, closed and covered over sites. The assessment of landfills includes type of waste, age, underlying geology, thickness of unsaturated zone and thickness and type of overburden. It can enable the ascertainment of state of waste degradation, analyzing the leachate and generation of landfill gases (Davidson, 2011). The proximity of these sites to drinking water sources also need to be assessed for determining the potential threats to public health by waste disposal.

4. FACTORS GOVERNING CONTAMINATION OF GROUNDWATER BY DISPOSAL OF WASTE

The waste in landfills or refused dumps becomes the part of hydrological system within the environment. At the same time, the fluids generated from groundwater, snowmelt and rainfall and waste bring various biochemical reactions during degradation processes. The resulting leachate also migrated from dumps or landfills and has significant potential to pollute groundwater through infiltration of leachate runoff site or direct infiltration (Christensen, 2010). The risk to groundwater is very high by the sources of waste disposals in dumps or landfills. This risk is considered in context to three major controls i.e. production of leachate, migration of leachate and composition and loading of waste.

4.1. Waste composition and loading

The volume and composition of disposed waste vary according to different region and nations in context to the human activities, type of products and quantity of consumption within the communities. The under developed countries has high amount of discarded waste especially food related waste. However, this substance is not very toxic in itself but the decomposition of organic matter alters the chemical quality and enhances the risks of groundwater pollution. The manufactured waste such as plastics, metals and textiles are hazardous and it is more visible in high income countries (Barrett, 2005). The leachate production is more visible in high industrialized areas and it is quite hazardous. The waste disposal from industries contains high amount of anthropogenic contaminants. The major concern of countries is related to import of

waste especially hazardous waste category. The export from industrialized areas to low income areas restricts the regulations of waste disposal. The practices of import and export are difficult to be identified but they are equally important for assessing the situation of waste disposal and risk of groundwater contamination (Johnson, 2010). Therefore, it is necessary to collect the information formal as well as informal composition of waste and loading. The below table indicates the generation of solid waste in different regions. The major composition of waste includes paper, food, glass, plastic, textiles, metals and others.

Table 1 Generation of solid waste in different regions of world

Location	Rate (kg/pers./year) (Including waste of paper, food, plastic, glass, textiles, metals and others)
China	285
Denmark	520
France	560
Iran	324
Mexico	320
Poland	290
USA	730
Abidjan	211
Nigeria	153
Tanzania	142

4.2. Leachate production

Most of the waste in landfills and dumps are not inert. The degradations of various components of waste such as paper, food, textile consumes oxygen and therefore, changes the potential of liquid present and mobility of constituents. The components such as metal, plastic, glass are less reactive and degrade in slow process (Barrett, 2005). There are exceptional conditions in which metals are mobilized rapidly. The percolation of rainwater provides a medium for waste to undergo the degradation process through biochemical reactions within the sumps and landfills. It is also indicated that there is a large fraction of disposed waste which has proper path of degradation (Spongberg, 2000). The origination of leachate process can be divided in major groups i.e. suspension of specific matter, hydrolysis of biological degradation and solid waste, solubilisation of salts within the waste. The hydrolysis and solubilisation process have great influence on the composition of leachate production and ultimately, connected to the waste stabilization.

4.3. Leachate migration

The process of water percolating through landfills and dumps are mostly accumulated below the landfill or mound. It is possible because of high leachate production with the degradation process within the waste and percolating rainwater through waste. The increment of hydraulic properties also promotes flow of leachate from landfills and dumps. There is a considerable threat of downward flow from landfill for underlying resources of groundwater whereas, the outward flow results in the leachate springs and yields poor quality of water in the waste deposit periphery (Herbert, 2007). The leachate springs and poor water quality in boreholes and well indicates production and movement of leachate in significant manner (Barbalace, 2013). The leachate springs is a major threat of public health and it is necessary to prevent access of such springs. One important method of reducing the leachate generation is

hydraulic heads and closing the landfill by capping the clay or high density polythene material over waste deposit. It will reduce the rainwater infiltration. This process need to be recorded because the landfill is capped for impeding the reduction of leachate production and ingression of rainwater. Also, there is a high potential of groundwater pollution in older capped landfills as compared to new capped and open landfills (Chadwick, 2012). The biochemical and microbiological reactions will result in prolonged process of degradation and activities of waste for decades (Riediker, 2011). The migration of leachate also gets affected from the way of deposition of waste. The waste compaction reduces the permeability and the regular application of topsoil covers the waste loading to landfills. The temporal nature of leachate springs mainly appears in wet seasons and will not appear in dry seasons and leaves the soil patches. The potential leachate production needs to be evaluated by focusing on specific periods such as end of wet season and events of excessive rainfall. The proper monitoring of leachate migration from landfills to the waste deposits will address the issues of management and planning. Despite of various complexities in the migration of landfill, the aspects of subsurface contaminants need to be reviewed in considerable manner (Freeze, 2009). The leachate production undergoes in major transitions of flow of groundwater until the conditions reaches to the redox levels and when the flow is not anaerobic. Within the transition zone, the species such as ammonia, methane disappears and converted into sulphur, nitrogen and other oxidized forms (County, 2009). The understanding of leachate plumes also indicates that they do not extend more than 100 meters from landfill. There are certain processes which reduce contaminant concentrations in the groundwater and removes contaminants from the solution. These concentrations are not reactive species in leachate and can only be reduced through dilution or dispersion. The dilution extent can reduce the waste derived concentrations within the leachate adjacent to landfills or dumps depending on the magnitude of leachate flows and groundwater flows (Wall, 2005). With the migration of leachate, the waste is deposited in particular flow direction of groundwater and dispersion of leachate plumes. The concentration of conservative and reactive contaminants decreases by the time along with flow of groundwater. It is important to consider that concentration of specific pollutant removed from the source may vary in different seasons of year on release and recharge of contaminant or times of reactions governed by factors like temperature and other important factors.

5. ASSESSING GROUNDWATER CONTAMINATION ASSOCIATED WITH WASTE SITES

It is important to assess the possibilities of groundwater contamination through wastes and specific disposals within the drinking water catchment. There is sufficient information for determining the potential of pollution and in the same manner, waste information like deposited waste, management of waste site and location of site in context to vulnerability of aquifer. It is not easy as the hydraulic gradient and hydraulic conductivity are highly dependent on the permeability of aquifer (Gandy, 2013). The velocity of flow can be different and have several magnitude orders at different times. Also, different types of contaminants may migrate in different velocities. There are various countries which utilizes concepts of drinking water zones for delineation of boundaries for the specific activities. The waste disposal is strictly prohibited in the drinking water zone within these countries. It is important to understand the hydrology settings so as to avoid problems of delineation (Schneider & Johnson, 2012). The valuable assessment and implementation measures will protect the specific water zones in significant manner. Also, reviewing the basis of

delineation process will help in understanding the hydro-geological settings and determination of vulnerability of aquifer. It is indicated that the poor hydro-geological settings need to be improved and it is a good approach for assessing the potential of pollution from waste to investigate the distance between drinking water abstraction and waste disposal and also, assess the potential hazard on the basis of landfill, attenuation and migration of leachate. The regular monitoring of operative landfills is necessary to improve conditions of waste management and groundwater pollution (Freeze, 2009). The attenuation and degradation processes within the plume results in front of plume and keeping pace with the degradation processes. The plume and other pollutants migration degrades rapidly and attenuated within some meters. The buffering distances are also evaluated which are utilized in selection of various sites and they indicated that the distance of individual dwellings with water wells in rural areas and usually, 500 meter is used widely except in extreme cases constitutes safe distance from water abstraction point to landfill. This distance can also be reduced on the side of landfill if the groundwater flow direction is known (Barbalace, 2013). It indicates that they do not exceed the landfill width and also, plume does not come out from landfill in the flow direction of groundwater (Johnson, 2010). In case of proper information about hydro-geological settings like aquifer type, flow direction of groundwater, velocity flows etc; it will lessen the distances of order on upstream sides of landfill.

Overall, it can be considered that a distance of 500 meter is adequate in most of the chases and 100 meter distance is very conservative while assessing the landfill with safe distance from water abstraction point. On the contrary, there are various human activities which cause the potential of groundwater pollution and landfill to the point sources. It facilitates the assessment of potential of pollution through monitoring and screening programs. These programs may not require chemical analysis of pollutants but it will select few substances such as C1, NH3 for detection of leachate plume migration (Cotton, 2009). This approach reflects the main influence on the landfill leachate exert on concentration of individual substances within the groundwater. It is also valid for organic contaminants which are exclusive to anthropogenic and its presence in groundwater and indicates the influence of waste sites and also valid for the occurring inorganic constituents of groundwater and content of landfill leachate (Davidson, 2011). The migration of leachate can be assessed with analysis the concentrations of various inorganic parameters in down-gradient groundwater from landfill in relation to the groundwater concentrations (Spongberg, 2000). It is important to rank the impact on groundwater of migration of leachate from landfill and it uses contamination factor which represents the ratio of measured concentration within the groundwater. This approach also identifies the particular inorganic substances with high factors of contamination and they are likely to be associated with leakage events of landfill. Therefore, it is suitable for indications of groundwater contaminations by landfills. It also indicates possibilities of occurrences of groundwater contamination from landfills with high substances load which may be hazardous because of toxicity and persistency if it can move through aquifer towards the supply of water.

6. CONCLUSION

The study has focused on waste disposal and landfills. It has mainly overviews the concerns of solid waste and its management in different areas. The major considerations of study include generation of solid waste, composition, management practices in different areas. It has provides suitable information on waste disposal and

landfills and its impacts on factors of pollution. The different types of solid waste are detailed for understanding the basics of waste management. Then after, the study focused on storage, treatment and disposal of waste and factors governing contamination of groundwater by disposal of waste. In later sections, the study has concentrated on the assessment of groundwater contamination associated with waste sites. It has also provided detailed information about landfills and controls of groundwater pollution. The study is helpful for policy decision making for issues such as sanitation water pollution, climate changes and public health.

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